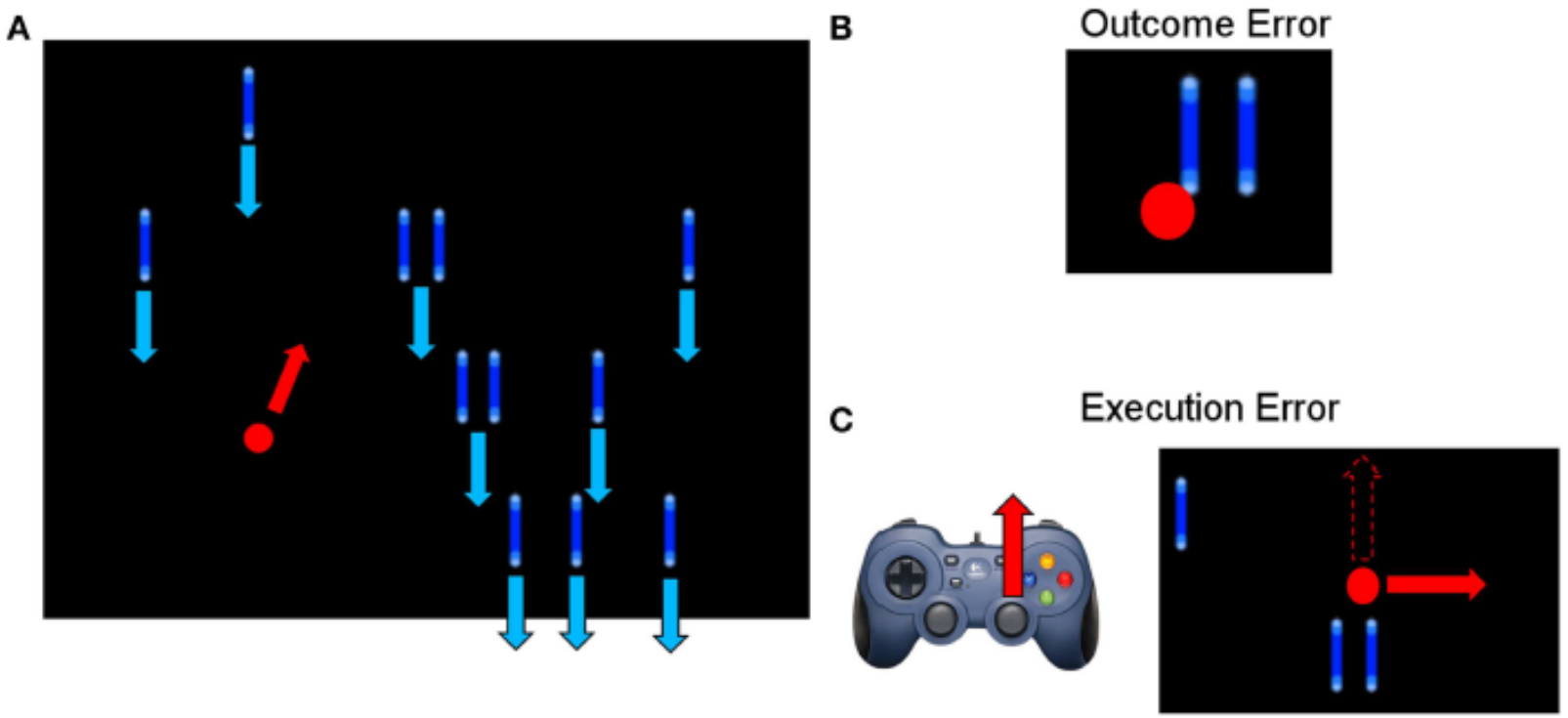
PIPELINE

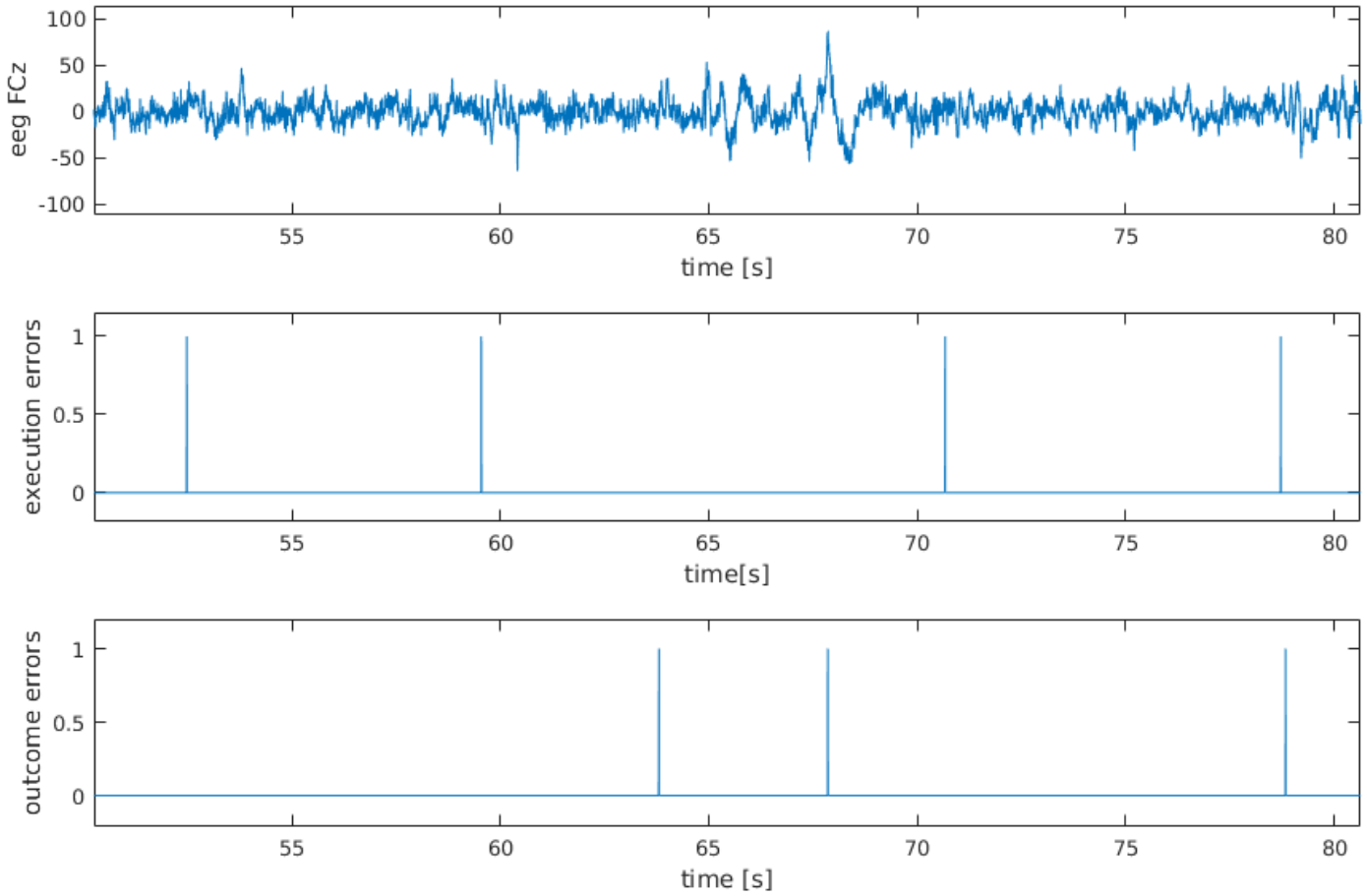
1. **Experiment**
2. **Data:** EEG, Execution, Outcome errors
3. **Data segmentation:** Synchronous Vs Asynchronous case
4. **Feature extraction:** Temporal and Spectral features
5. **Dataset split. Classifier Training, Testing and Statistics**

EXPERIMENT



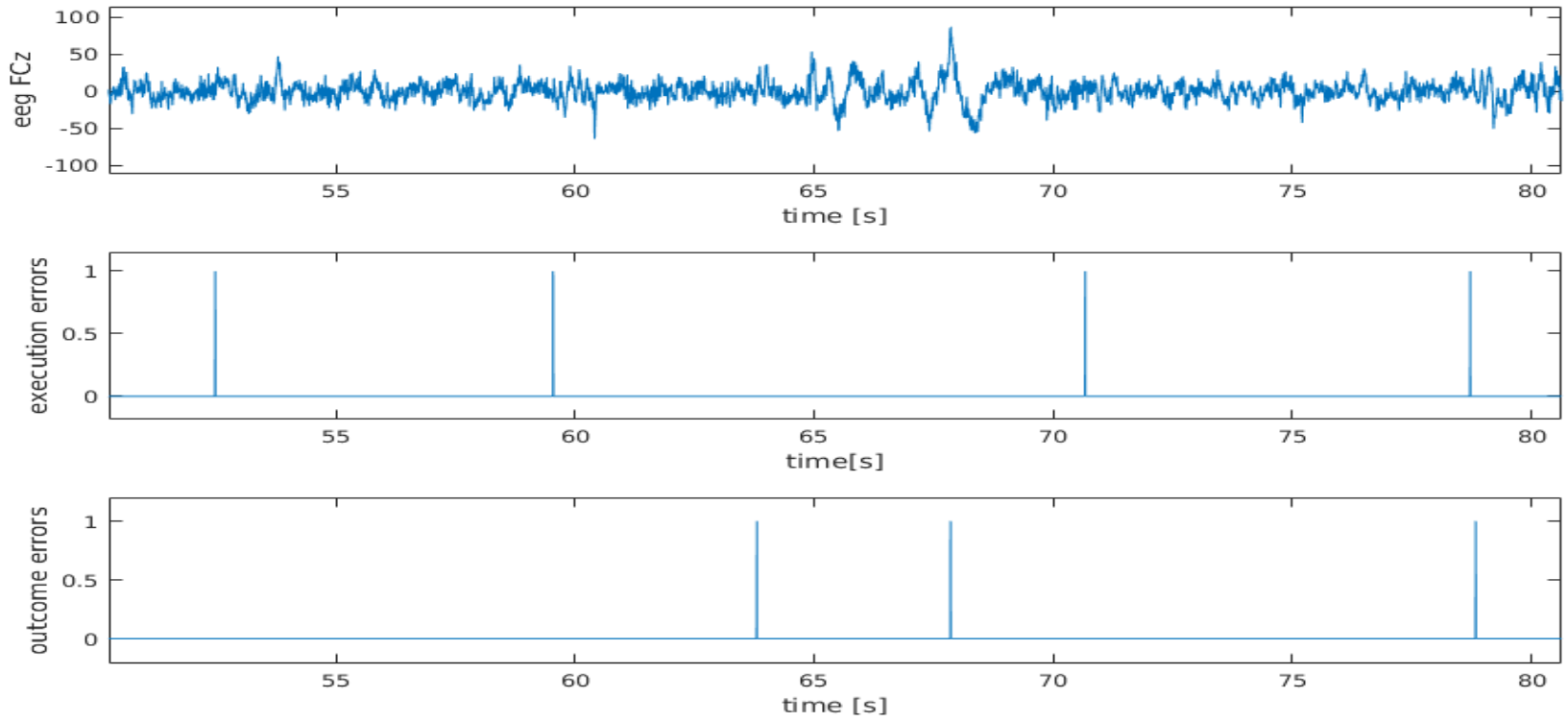
Source: https://www.frontiersin.org/articles/10.3389/fnhum.2015.00155

DATA

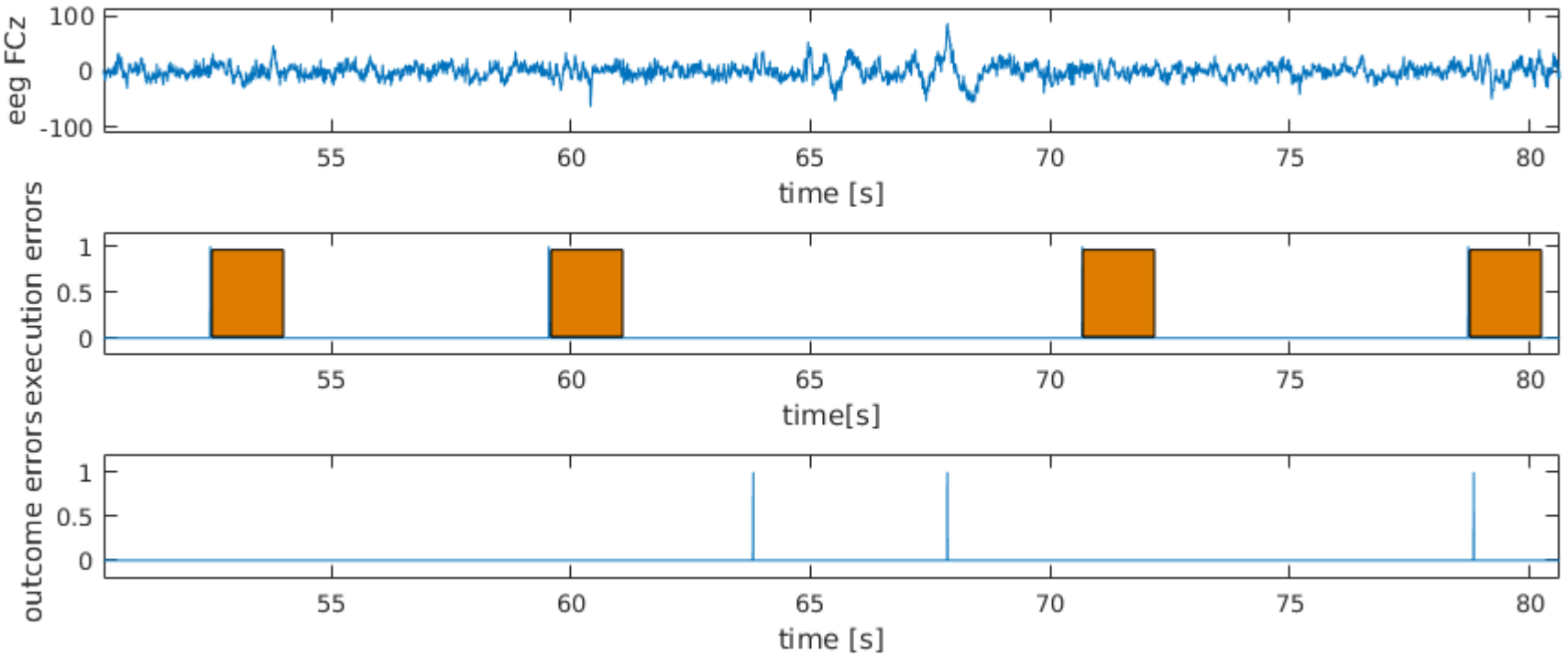

eeg FCz
100
50
0
-50
-100
55
60
65
70
75
80
time [s]
execution errors
1
0.5
0
55
60
65
70
75
80
time[s]
outcome errors
1
0.5
0
55
60
65
70
75
80
time [s]

DATA SEGMENTATION
SYNCHRONOUS CASE

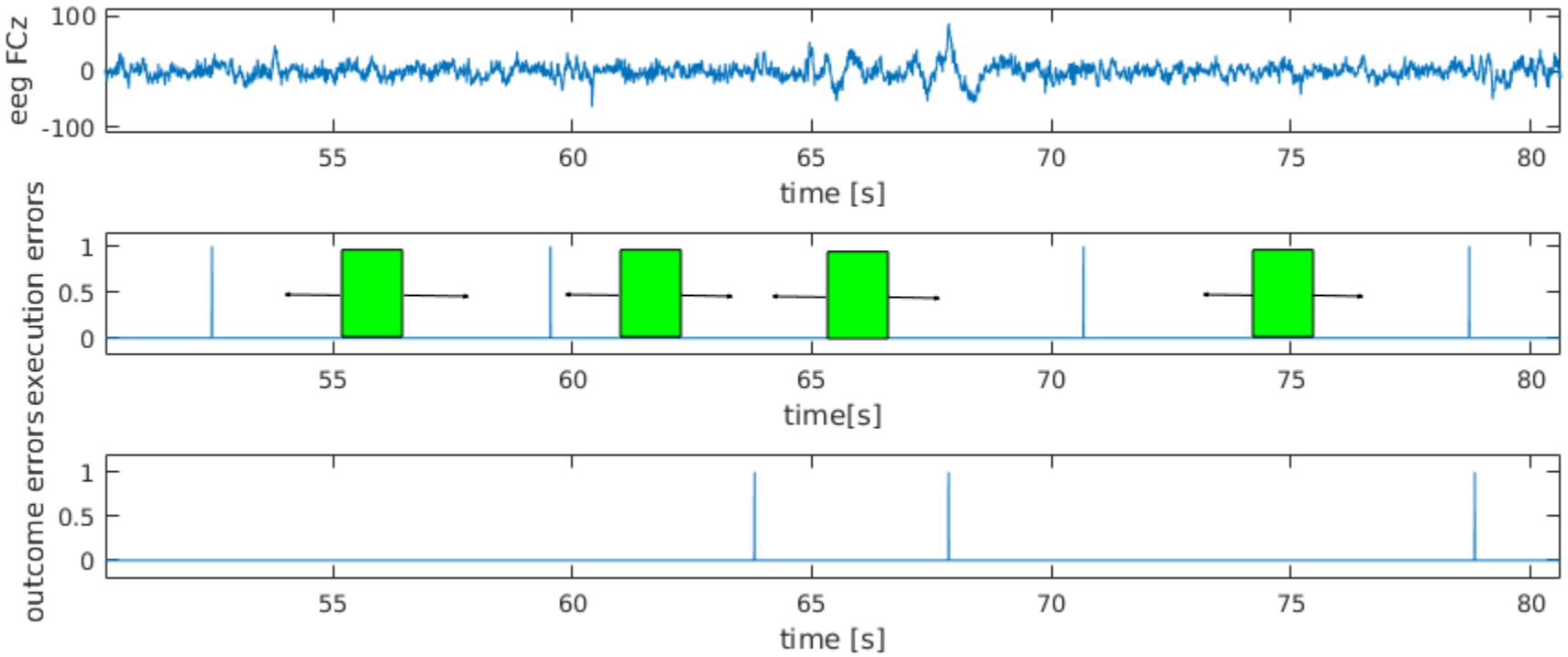
1 s trials associated to specific events



DATA SEGMENTATION
SYNCHRONOUS CASE



DATA SEGMENTATION
SYNCHRONOUS CASE



EXPERIMENT
SYNCHRONOUS CLASSIFICATION

Temporal Features
- EEG samples of all the channels in the sub_window [0.2, 0.9]s (flattened)
- N_features = sampl_freq*0.7*n_channels

Spectral Features:
- PSD of the signal of all the channels in the sub-window [0.2, 0.9]s (flattened)
- Ensemble spectral averaging (Welch) with frequency resolution = 1Hz
- Interesting frequencies = [1, 40]Hz. N_features = 40*n_channels.

Classification
- Experiments = 10-fold CV with chronological splits. 9 splits train, 1 split test.
- Linear Ridge Classifier, with optimized lambda
- Balanced classes → Baseline accuracy ~ 50%

RESULTS

SYNCHRONOUS CASE (average classification accuracy for 10-fold CV)

	Temporal feats	Spectral feats	Temp + Spectr feats (concat)
Sbj1	76.42	68.54	76.12
Sbj2	71.16	67.56	71.16
Sbj3	67.37	62.26	67.37
Sbj4	66.10	54.25	66.00
Sbj5	64.64	61.54	64.84
Sbj6	62.5	62.0	62.0
Sbj7	62.23	57.74	62.53
Sbj8	67.01	62.47	67.02
Sbj9	64.48	64.09	64.0
Sbj10	69.52	61.44	69.01
Average (sbj)	67.14	62.19	67.01

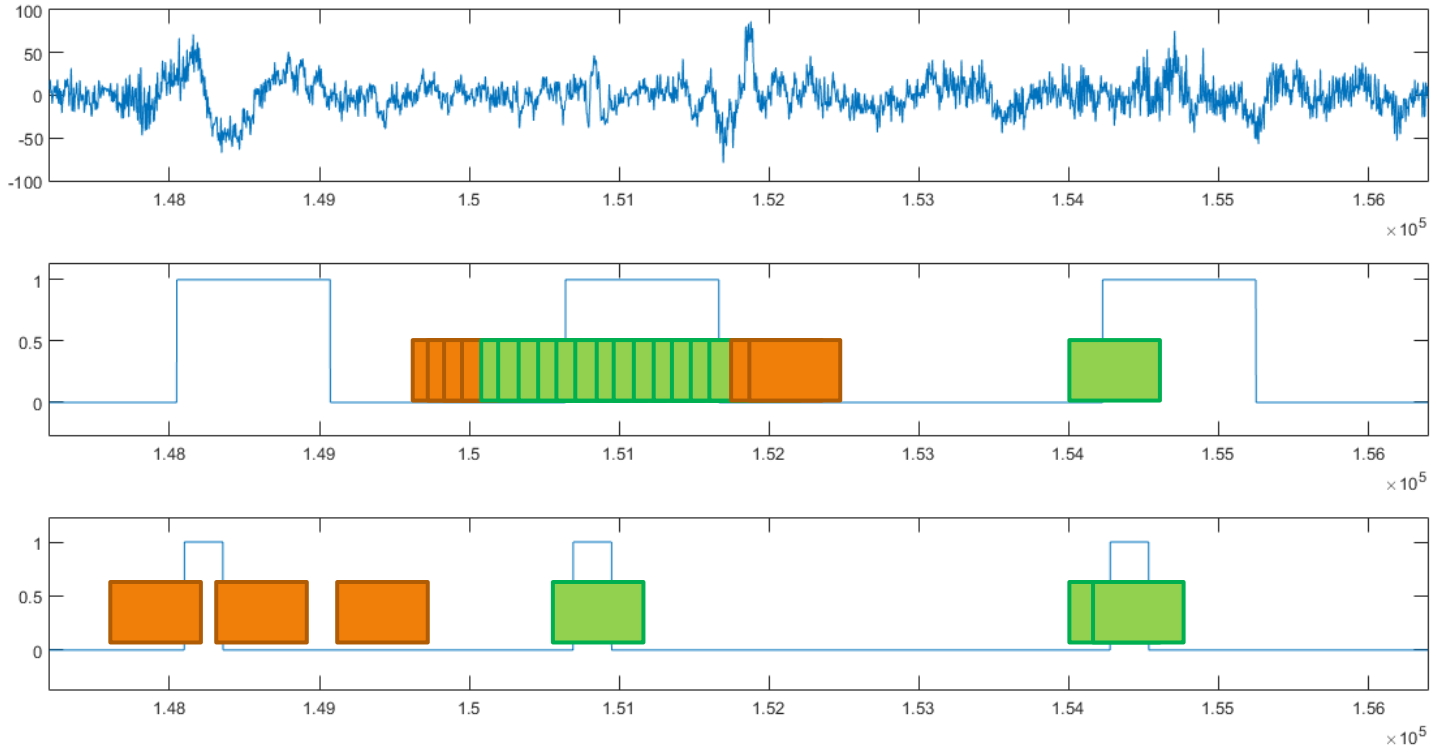
ConfMat Temp feats	True -	True +
Pred -	0,33	0,17
Pred +	0,15	0,34

TPR = Recall = 0,66
TNR = 0,68
FPR = 0,31
FNR = 0,34
Precision = 0,69

Classes are approximately balanced -> Baseline performance: 50% classification accuracy

DATA SEGMENTATION
ASYNCHRONOUS CASE

1 s trials, associated to a sliding window with a stride of 62,5ms



EXPERIMENT
ASYNCHRONOUS CLASSIFICATION

Spectral Features:
- PSD of the signal of all the channels in the sub-window [0.1, 0.5]s (flattened)
- Ensemble spectral averaging (Welch) with frequency resolution = 1Hz
- Interesting frequencies = [1, 12]Hz. N_features = 12*n_channels.
- R2 to select the best 20 features

Classification
- Experiments = 10-fold CV with chronological splits. 9 splits train, 1 split test.
- Weighted Linear Ridge Classifier, alpha=C^-1=1
- Umbalanced classes (84% noErr)
- Metrics for umbalanced classes = AUC of the ROC (FNR/TNR), balanced accuracy (bsl=50%)

Differences with paper's procedures
- Paper computes spectrum using Burg's ME method. It runs really slow in Python and performs the same as Welch (tested on sbj1, sync).
- Paper adopts weighed linear SVM as default classifier. It runs really slow in Python (async case) and performs the same as weighted Ridge Classifier (tested on sbj1).

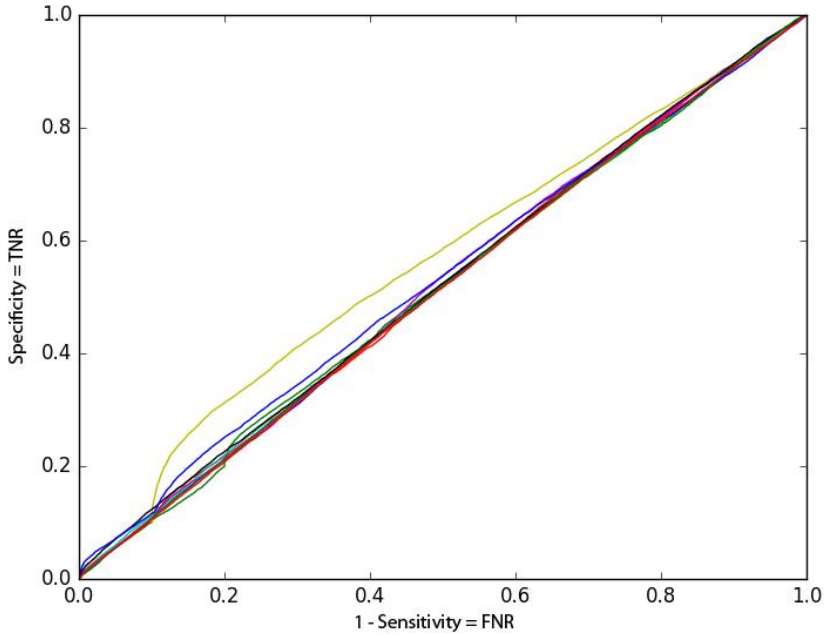
RESULTS

ASYNCHRONOUS CLASSIFICATION (average classification accuracy and AUC for 10-fold CV)

	Spectral feat, bal clf acc	Spectral feat, AUC of authors' roc
Sbj1	52,63	0,54
Sbj2	52,64	0,52
Sbj3	51,77	0,52
Sbj4	51,55	0,51
Sbj5	52,05	0,52
Sbj6	58,03	0,51
Sbj7	51,69	0,52
Sbj8	53,61	0,54
Sbj9	51,49	0,52
Sbj10	50,84	0,51
Average	52,63	0,52

	True -	True +
Pred -	0,21	0,13
Pred +	0,37	0,29

TPR = Recall = 0,69
TNR = 0,36
FPR = 0,63
FNR = 0,31
Precision = 0,44



Umbalanced classes → Baseline performance: 50% balanced classf accuracy, 0,5 AUC